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Fairlie

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[54] **TRUSS JIGGING SYSTEM**

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[52] **U.S. Cl.** **364/468.21**; 269/37; 269/910

[58] **Field of Search** 364/468.21, 468.01, 364/474.01, 474.02; 269/910, 37; 29/281.3; 100/913

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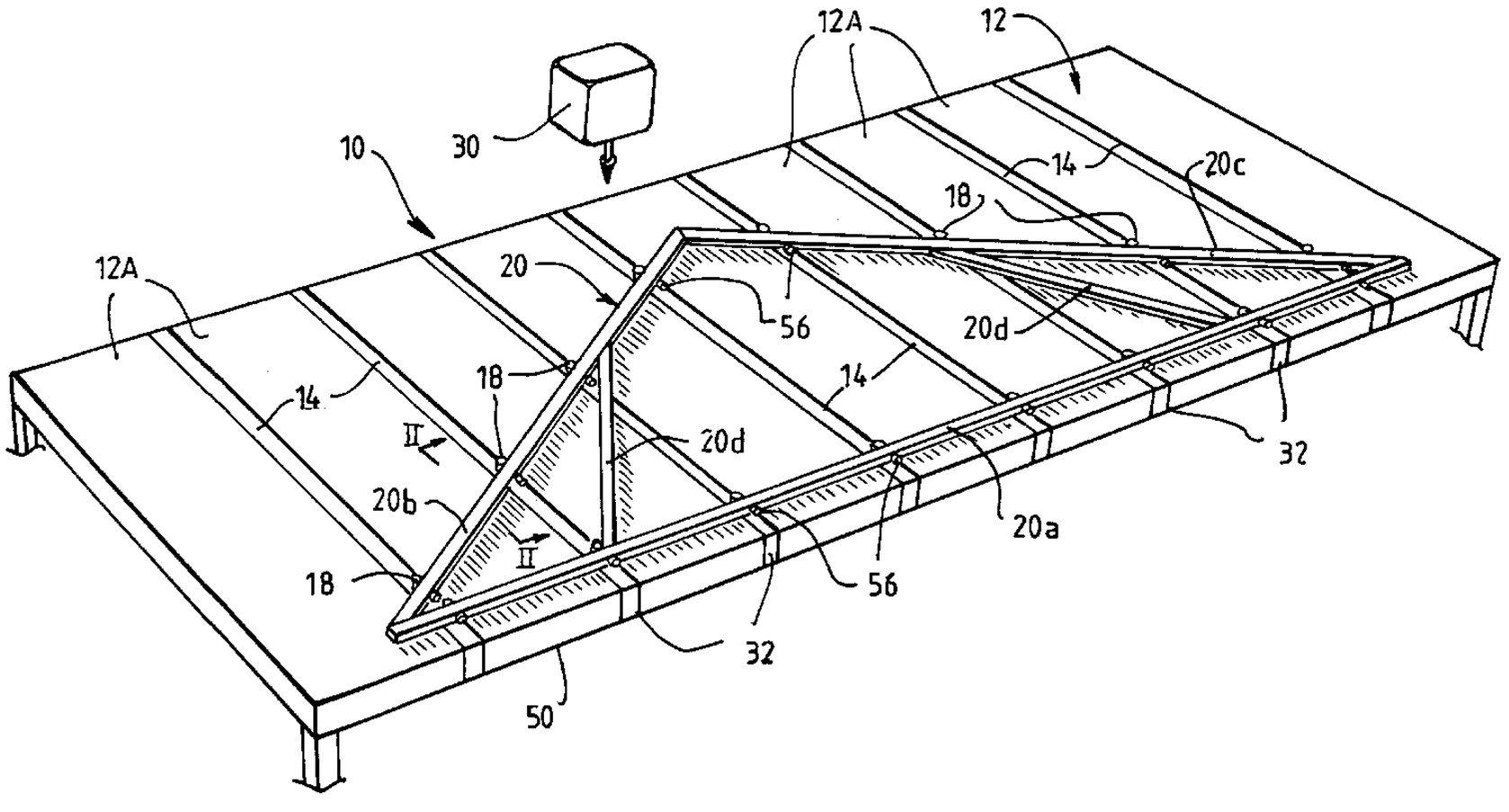
[57] **ABSTRACT**

A jig system is disclosed which includes an assembly table which has a plurality of slots which extend across the width of the table. Pucks are arranged for movement along the openings on carriages which are mounted for sliding movement on rails. The carriages are connected to endless belts which travel around pulleys under the control of a motor for in turn moving the carriages to position the pucks. The motor is controlled by a computer and controller. The carriage has springs which support a plate so that the plate is biased upwardly above the table. Connectors may be located beneath a workpiece supported on the support surface so that when a force is applied to the plates, the plates and workpiece move downwardly against the bias of the springs so that the connector is forced into the workpiece. Cylinders and arms are provided for clamping the workpiece against the pucks. The pucks, cylinders and arms are provided on the support plate.

20 Claims, 3 Drawing Sheets



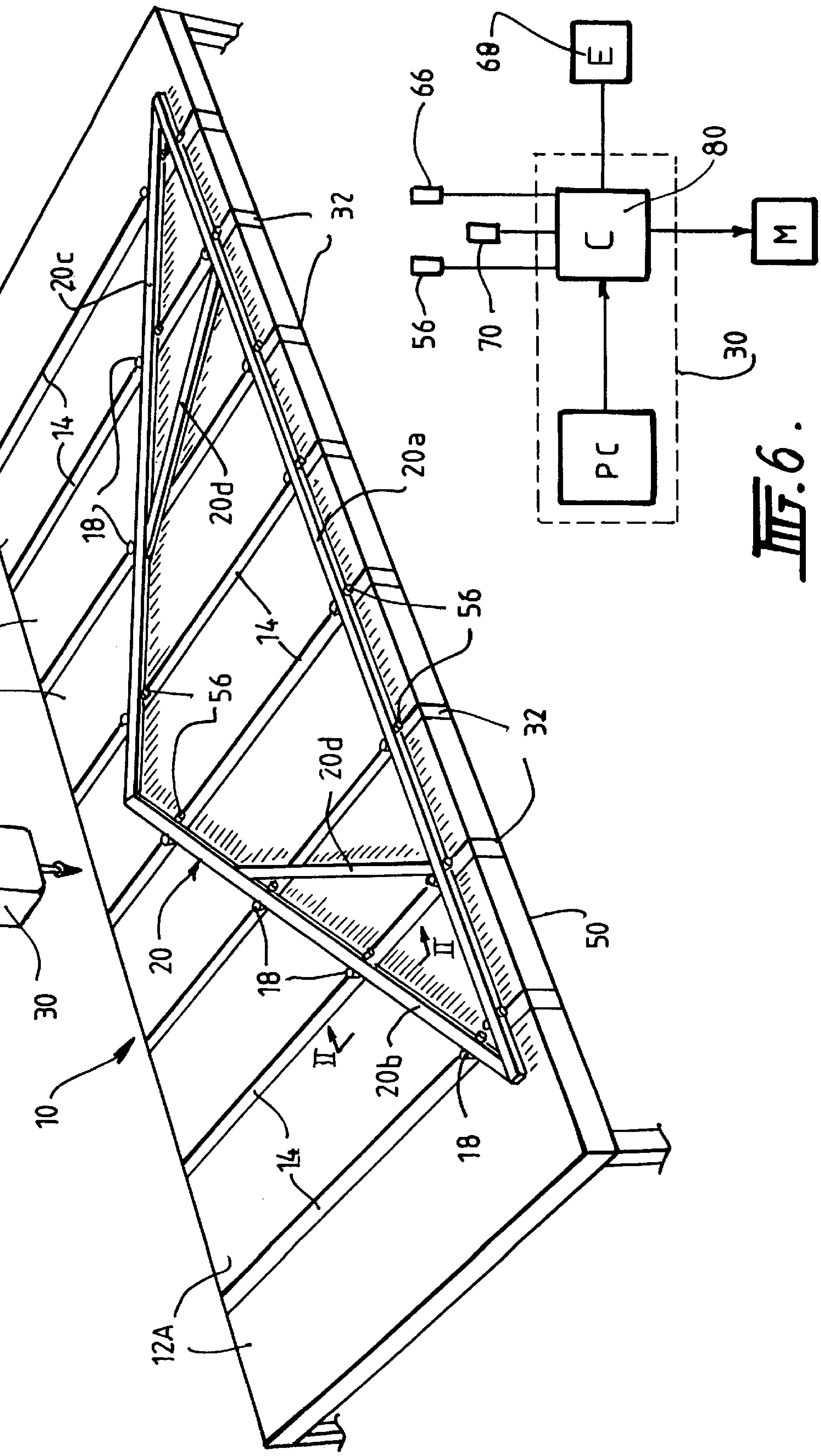
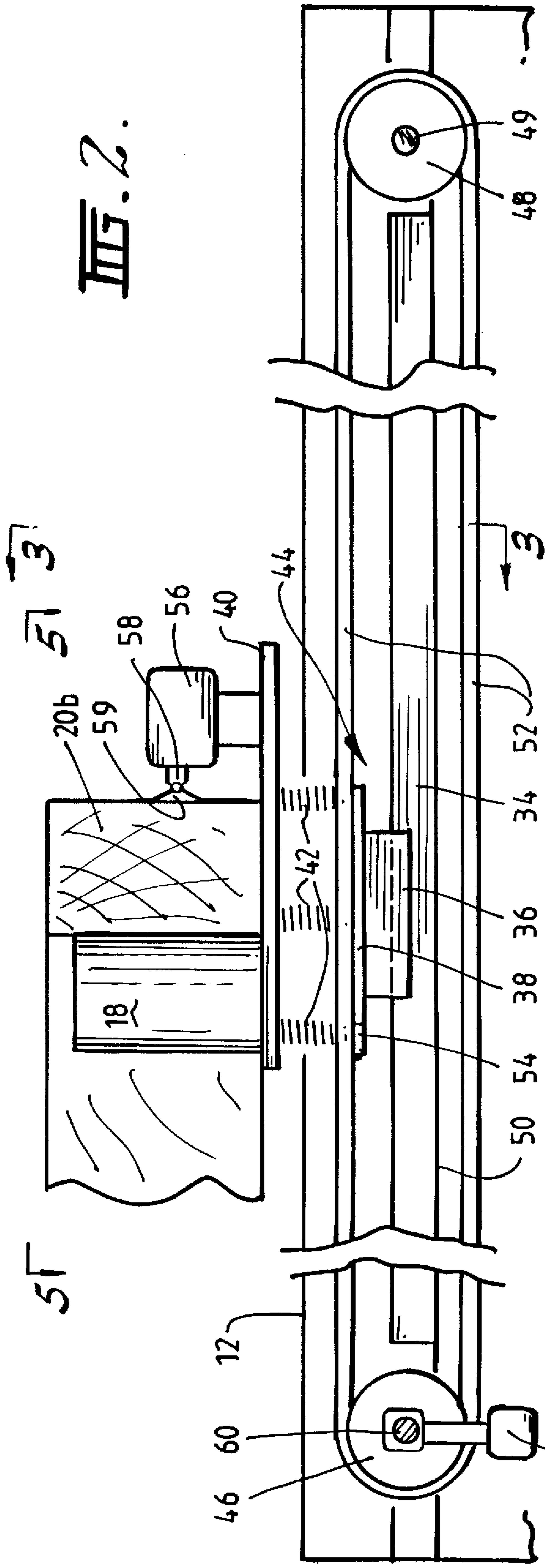

10
12
12A
14
18
20
20a
20b
20c
20d
30
32
50
56
II

FIG. 1.

E
C
M
PC
56
66
68
70
80
30

FIG. 6.

FIG. 2.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58
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20b
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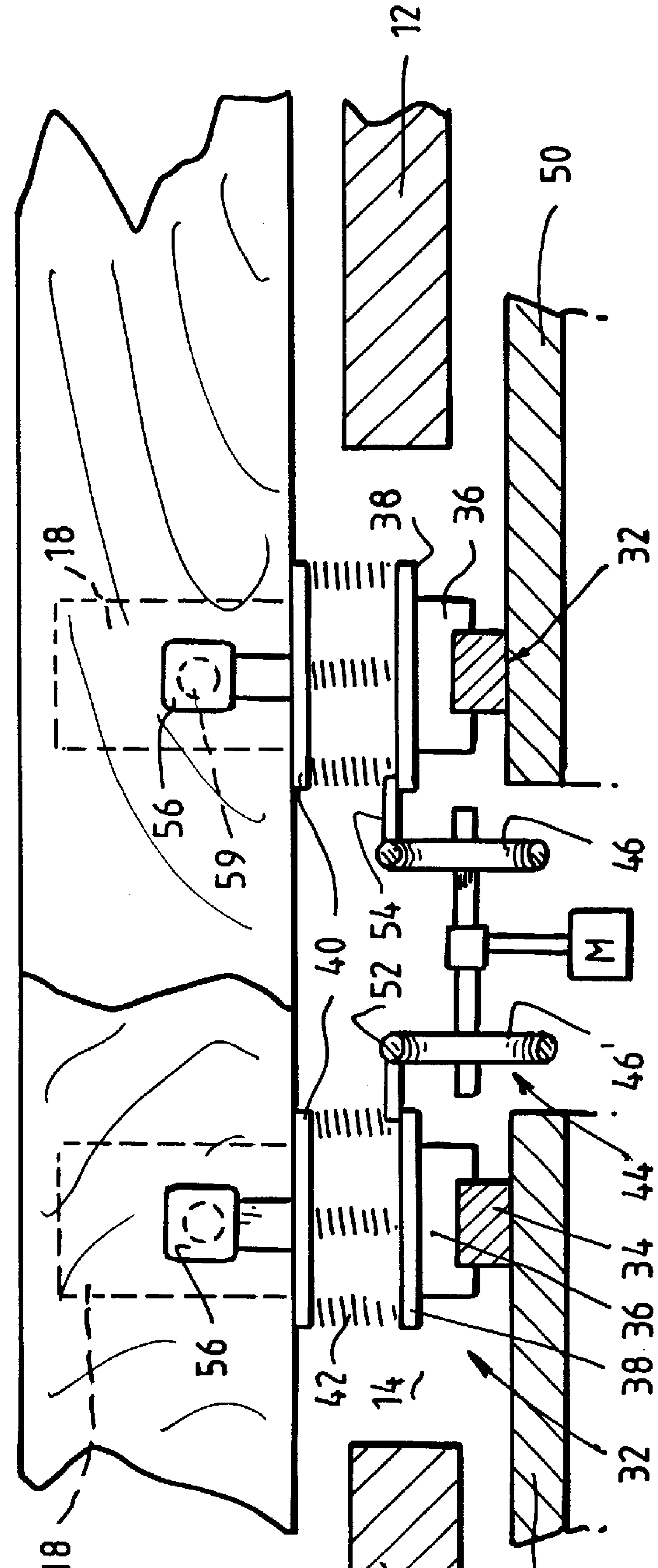
60
46
M
49
48

FIG. 3.


12
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18
38
36
32
56
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46
52
M
44
34
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38
42
14

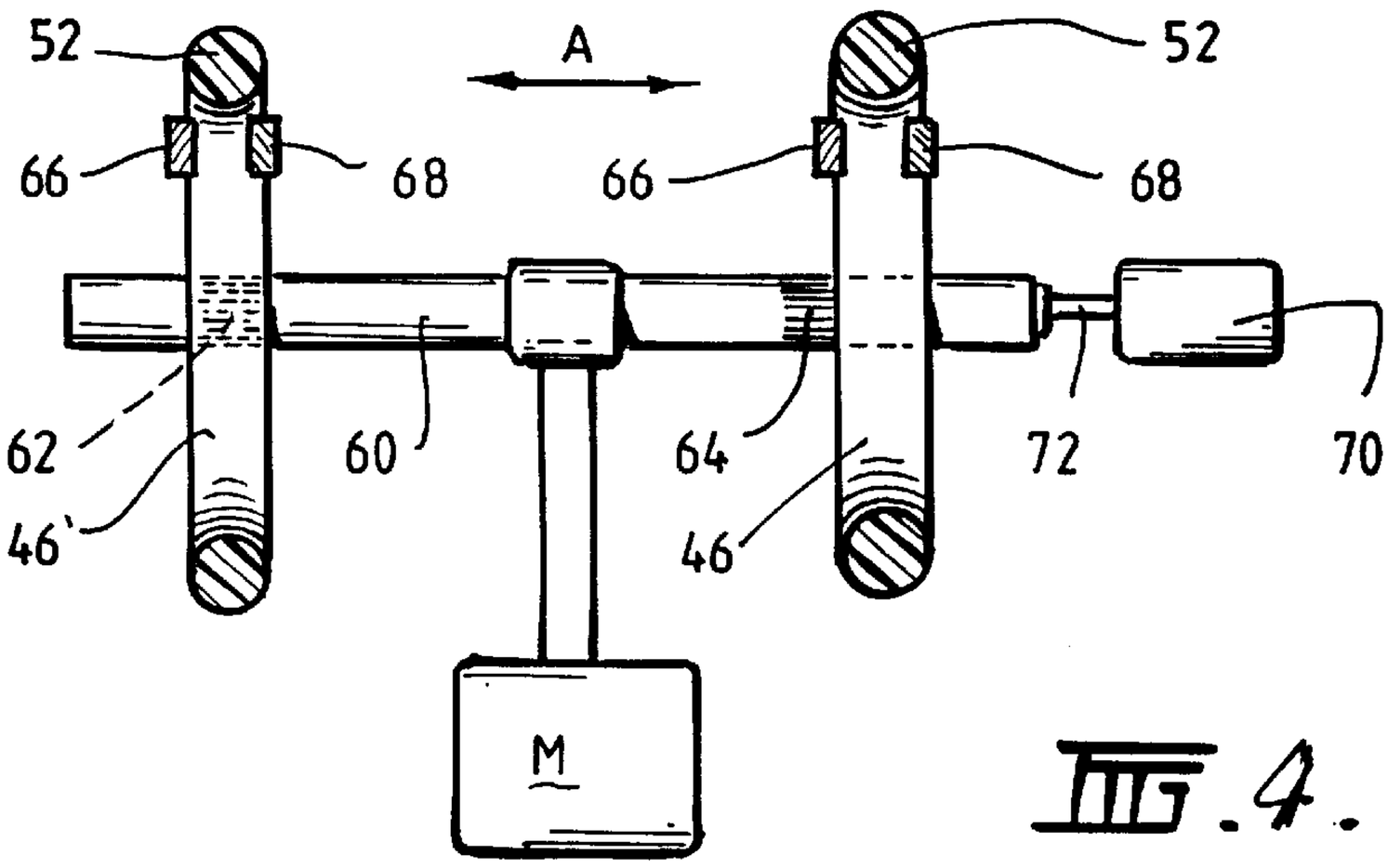

FIG. 4.

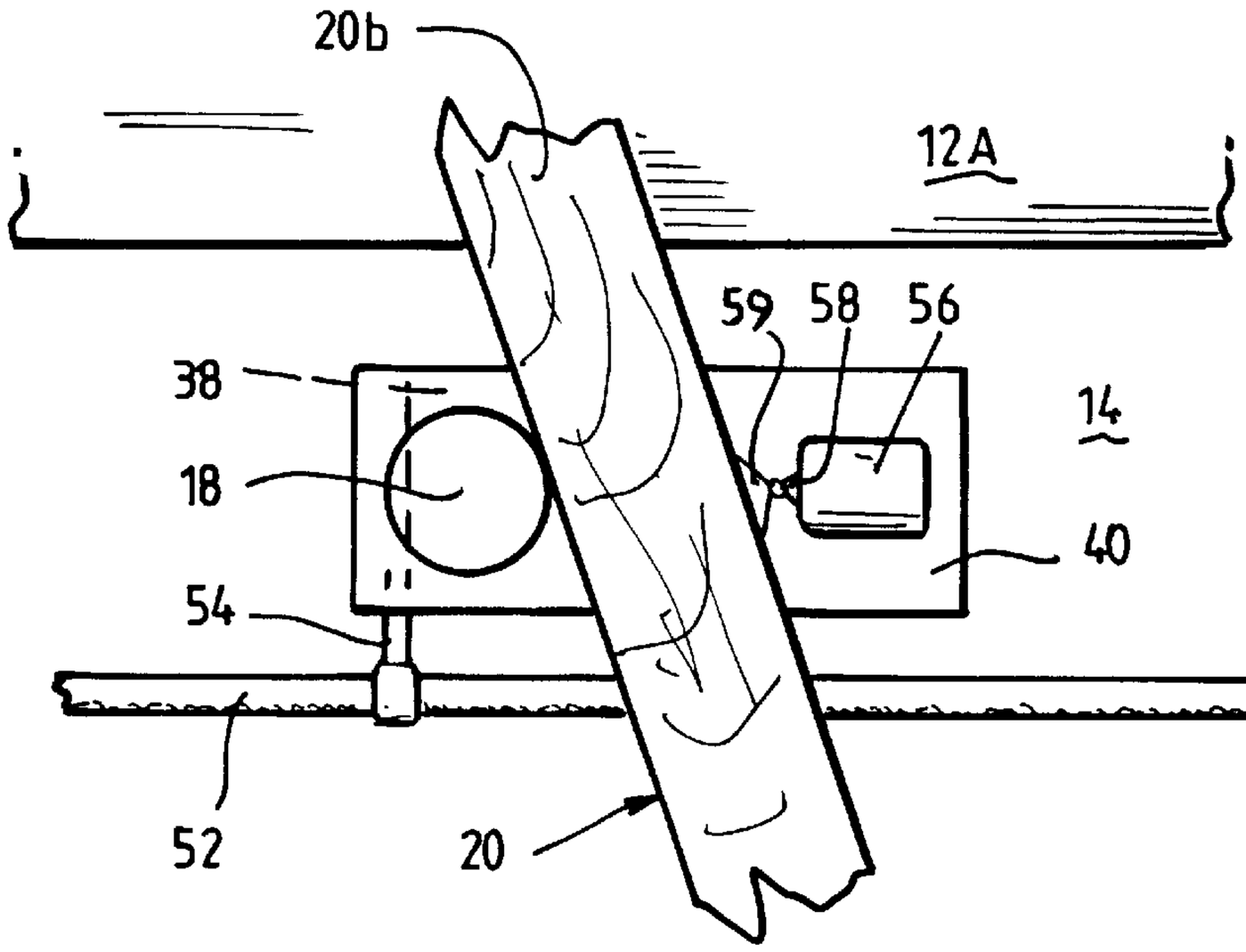

FIG. 5.

FIG. 7.

TRUSS JIGGING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a jigging system for work pieces, and in particular, to a jigging system for the assembly of wooden trusses for use in building.

Wooden trusses generally comprise a number of wooden elements including a bottom chord, upper chords which are generally arranged in a V-shaped configuration, and connecting pieces between the chords. The chords and connecting pieces are joined together by metal connector plates which are usually forced into the joints between components on both sides of the truss by a suitable press or the like. Conventionally, the components from which the truss are to be made are laid out on a table which has stops (often referred to as pucks) for setting the position of the chords.

U.S. Pat. No. 5,085,414 to Weaver discloses a support table which has upwardly opening channels along which stops can slide. The stops are manually positioned and locked into predetermined positions in the channels dependent upon the shape of the truss which is required. The chords of the truss are then located against the stops to define the shape of the truss and connector plates are located and forced into the components to form the truss.

Manual location of the stops requires a considerable amount of time and in order to decrease the time taken to set up a jig for manufacturing a truss, automatic truss jigging system have been proposed.

One such automatic system is disclosed in U.S. Pat. No. 5,092,028 to Harnden. This jig utilizes a plurality of lead screws which are arranged in the channels. The lead screws carry the stops and stepper motors are provided for rotating the lead screws to drive the stops along the channels to locate them in a predetermined position. U.S. Pat. No. 5,342,030 to Taylor also discloses an automatic system in which a gantry and gantry carriage is provided on the table for moving the stops along the channels to locate them in a desired position.

Although Harnden and Taylor provide automatic relocation of the stops, which permits the truss assembly table to be reconfigured somewhat more quickly than Weaver to accommodate a different truss, additional improvements may be made. The lead screws of Harnden move the stops relatively slowly across the width of the truss assembly table, even at high rotational speeds of the lead screws. The gantry of Taylor moves only one stop at a time, and then must be moved longitudinally to the next slot in the table where a stop is to be relocated. Thus, there is still a need for a more rapid automatic truss assembly table set up system.

SUMMARY OF THE INVENTION

Among the several objects and features of the present invention may be noted the provision of a jig system which can be rapidly re-configured for forming trusses of different shapes; the provision of such a jig system which re-configures itself without manual intervention by laborers; the provision of such a jig system which rapidly re-positions powered clamps; the provision of such a jig system which readily receives wooden members that are curved; the provision of such a jig system which permits placement of connector plates on both the top and bottom sides of truss members in the jig system at the same time; and the provision of such a jig system which is easy to use.

Generally, a jig system for use in arranging components to form an assembly such as a truss comprises stops mounted for translational movement generally along respective lines to desired positions for locating the components to form the assembly. Stop moving means comprises a motive source and a driver acted on by the motive source for moving the driver. At least part of the driver moves in a direction parallel to the line of movement of the stop. Means connects the driver to the stop for moving the stop along its line of motion to the desired position.

In another aspect of the present invention, a jig system having stops and set forth above, and clamping means for clamping the components against the stops. The clamping means is operable to clamp components against the stops in different desired positions of the stops.

In yet another aspect of the present invention, a jig system is used in association with reaction surface means to arrange components to form an assembly such as a truss, and to support the components as connectors are driven into the components to connect the components together. Generally, the jig system comprises stops for locating the components to form the assembly and component supports for supporting components of the assembly. Resilient members supporting the component supports away from the reaction surface means, so that connectors may be positioned between the components and the reaction surface means, are resiliently yieldable under a force applied to the components to move the component supports to press the connectors and the components against the reaction surface means to drive the connectors onto the components.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a jigging system according to the preferred embodiment of the invention;

FIG. **2** is a view along the line II—II of FIG. **1**;

FIG. **3** is a view along the line III—III of FIG. **2**;

FIG. **4** is a detailed end view of part of the assembly of FIG. **3**;

FIG. **5** is a top plan view from the vantage indicated by the line V—V of FIG. **2**;

FIG. **6** is a schematic view of a control system for controlling the jig of FIGS. **1** to **5**; and

FIG. **7** is a view showing a connector plate beneath a truss joint.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, an assembly table **10** is shown which may typically be up to 30 meters in length and 4.2 meters in width. The table **10** has an upper platform generally indicated at **12**, formed from solid sheets **12A** or rails or the like which are spaced apart to provide a plurality of openings **14** which, in the embodiment of FIG. **1** extend across the width of the table. Rather than extend across the width of the table as shown in FIG. **1**, the openings **14** could also extend lengthwise or at an angle across the table if desired. The upper platform **12** constitutes reaction surface means in the preferred embodiment.

Arranged for movement along the openings **14** in a manner to be described hereinafter are a plurality of stops or pucks **18**. Typically, the shape of a truss **20** is known and its details are fed into a control system **30**, which controls movement of the pucks **18**. The pucks **18** are then moved in a manner which will be described hereinafter to positions needed to locate truss components for forming the truss **20**. Chords **20***a*, **20***b*, **20***c* from which the truss is to be formed are laid out together with connecting pieces **20***d*, with the

chords abutting the pucks **18**. Connector plates are then located on both sides of the truss **20** at the joints of the chords **20***a*, **20***b*, **20***c* and the connecting pieces **20***d*, and the connector plates are driven into the truss **20** by presses or the like (not shown) to form the truss **20**. The truss **20** is then removed from the table **10** and new components, such as the chords referred to above, are located in place to form a new truss. If the shape of the new truss is different, the pucks **18** are first moved under the control of the control system **30** to new positions for locating truss components of the new truss.

With reference to FIGS. **2** and **3**, the mechanism for moving the pucks **18** will be disclosed. Each of the openings **14** is provided with two linear bearing head and rail assemblies **32**. Such devices are well known and therefore will not be described in detail hereinafter other than to say they comprise a rail **34** upon which a head **36** is mounted for sliding movement on the rail **34**. Each of the heads **36** carry a carriage **38** and each of the carriages **38** support a workpiece support plate **40** which is coupled to the carriage **38** by springs **42** which bias the plate **40** upwardly to a position above the platform **12**.

The assemblies **32** are supported on a suitable support frame **50** which is mounted beneath the table **10**. Also supported on the frame **50** are two pairs of pulley and endless belt assemblies **44**. As best shown in FIG. **2**, each assembly **44** comprises a driven pulley **46** (broadly, "a driver") and a tensioner pulley **48** about which an endless belt **52** can travel. Each of the endless belts **52** (broadly, "means for connecting the driver to the stop") is coupled to one to the carriages **36** by a rigid clamp assembly **54** so that the carriages **36** are securely connected to the endless belts **52**.

A puck **18** is mounted on each of the plates **40**. The plates **40** also carry hydraulic, pneumatic or electromagnetically actuated cylinders **56** which have arms **58**. The arms **58** may be provided with a foot **59** for engaging the truss **20** as will be described in more detail hereinafter.

When the endless belts **52** are driven about the pulleys **46** and **48**, the carriage **38** is moved with the endless belt **52** and therefore the head **36**, carriage **38** and plate **40** together with the puck **18** and cylinder **56** also move with the belt **52** by virtue of sliding engagement of the head **36** on the rail **34**. The velocity of the surface of each driven pulley **46** engaging its corresponding belt **52** at the point where the upper reach of the belt leaves the surface of the pulley is substantially parallel to the line of motion of the corresponding puck **18** along the length of the opening **14**. The belt **52** is driven directly by the driven pulley **46** in a direction parallel to the line of motion of the puck at speeds closely corresponding to those of the speed of the surface of the pulley which engages the belt. Thus, the belt **52** and the puck **18** connected thereto may be rapidly moved along the length of the opening **14**. In contrast, the velocity of no point on a lead screw extending lengthwise under an opening in a truss assembly table is parallel to the line of motion of the puck. The rotary motion must be converted to linear motion in a direction perpendicular to the instantaneous velocity of any point on the lead screw, which is accomplished by a threaded connection of a puck carrier to the lead screw. As a result, the linear velocity of the puck driven by the lead screw is substantially less than the instantaneous velocity of a point on the lead screw.

It is envisioned that the belts **52** and pulleys **46**, **48** may be replaced by chains and sprockets, or that the belt may be replaced by a flexible cable or other endless flexible member, while retaining the same advantages stated above. Moreover, it is further contemplated that rodless or another type of cylinder (not shown) under each opening **14** could be employed in place of the belt **52** and pulleys **46**, **48**. It will be noted that in the case of the such cylinders, the driver would constitute the piston within the cylinder moved by pneumatic or hydraulic pressure. In that event the velocity of the piston would also be parallel to the permitted linear motion of the puck connected to it, permitting the puck to be repositioned as rapidly as the piston can be moved within the cylinder.

Each pulley **48** is mounted on a shaft **58** and forms an idler pulley or tensioning pulley for tensioning the belts **52**. The other pulleys **46** are mounted on a common shaft **60** which is driven by a motor M. The motor M is preferably a two speed motor having a high speed and a lower speed. However, it is to be understood that there could be a separate motor (not shown) for each drive pulley without departing from the scope of this invention. Moreover, the drive pulleys **46'**, **46** could be mounted for conjoint rotation with the motor shaft.

As is best shown in FIG. **4**, the shaft **60** is provided with a first set of splines **62** and a second set of splines **64**. The shaft **60** is arranged for movement in the direction of double headed arrow A relative to the pulleys **46** by a solenoid **70** which has an armature **72** coupled to the shaft **60**. Upon actuation of the solenoid **70**, the armature **72** is selectively pulled into the solenoid **70** or moved out of the solenoid **70** to thereby move the shaft **60** in the directions indicated by double headed arrow A. In the position shown in FIG. **4** in which the armature **72** is out of the solenoid **70**, the splines **62** engage corresponding splines on the pulley labelled **46'** in FIG. **4** so that upon rotation of the shaft **60** by the motor M, the pulley **46'** is driven to thereby move the endless belt **52** associated with that pulley. In order to switch drive to the other pulley **46**, the solenoid **70** is activated so that the armature **72** is drawn into the solenoid **70** thereby shifting the shaft **60** to the right in FIG. **4**. This will disengage the spline **62** from the pulley **46'** and engage the spline **64** with the other pulley **46** so that the other pulley **46** can be driven.

The pulleys **46** are provided with an encoder **68** for providing an indication of the position of the pulleys **46** to in turn provide an indication of the amount of movement of the belts **52** so that the position of the carriage **38** and therefore the pucks **18** can be determined. The pulleys **46** also have disc brake assemblies **66** for stopping and locking the pulleys **46** to thereby securely locate the pucks **18** at a desired position.

The cylinders **56** are positioned a suitable distance from pucks **18** so that when the arm **58** is retracted, a chord **20***b* of the truss **20** of the largest size which may be required can easily fit between the puck **18** and the cylinder **56**. The chords **20***a*, **20***b* and **20***c* are then laid out on plates **40** by locating the chords between the pucks **18** and the cylinders **56** with the chords **20***a*, **20***b* and **20***c* generally abutting corresponding pucks **18**. The cylinders **56** are then activated so that arms **58** are extended to cause feet **59** to engage the chords **20***b* and clamp the chords **20***b* against the pucks **18**. Thus, the chords **20***b* are securely clamped between the pucks **18** and the cylinders **56**. Clamping of the chords in this manner ensures that if the chords are curved slightly they are generally forced into the desired orientation hard against the pucks **18** to ensure that the truss **20** is properly positioned and does have the shape defined by the pucks **18**. The cylinders **56** are controlled by a manual switch (not shown) which is actuated after the chords **20***a*, **20***b* and **20***c* and the connectors **20***d* have been positioned.

When the chords **20***a,* **20***b* and **20***c* of the truss **20** are laid out on the jig, the chords rest between pucks **18** and cylinders **56** on the support plates **40**. Thus, the chords **20***a,* **20***b* and **20***c* which form the truss **20** are located above the platform **12** of the table **10** as is clearly shown in FIGS. **2**, **3** and **7**. This enables connector plates, such as plate P (FIG. **7**) to be located beneath the chords **20***a,* **20***b* and **20***c* so that those connector plates are located between the platform **12** and the chords **20***a,* **20***b* and **20***c*. Other connector plates are located on the top surface of the truss **20** and the truss **20** is then pressed by a suitable press to drive the connector plates into the chords **20***a,* **20***b* and **20***c*. As the press is operated, the truss **20** is forced downwardly against the bias of the springs **42** which support the plates **40** so that the truss **20** lowers onto the platform **12**. As the truss **20** is forced downwardly by the pressing action, the connector plates which were located on the platform **12** under the truss **20** are driven into the truss **20** so that the chords **20***a,* **20***b,* and connecting pieces **20***c* **20***d* are joined together to form the truss **20**.

Thus, the connector plates which are to be inserted into the lower surface of the truss **20** can be located in place without the need for lifting the truss **20**.

FIG. **6** schematically illustrates the control system **30** for controlling the jig. The control system **30** includes a portable computer PC which is coupled to a controller **80**. The controller **80** is then in turn coupled to motor M, encoder **68** and also controls solenoid **70** and disc brakes **66**. One controller **80** can be used to control, for example, six pucks **18** and therefore the controller **80** shown in FIG. **6** can be used to control both of the pucks shown in FIGS. **2** and **3** together with another pair of pucks arranged in another opening **14** and yet a further pair of pucks **18** arranged in yet a further opening **14**. In the instance where the table **10** has forty-two pucks, seven controllers **80** connected to the PC for controlling the jig are used. The controller **80** which controls each set of six pucks **18** will also control the associated motor M, encoder **68**, brakes **66** and solenoid **70** associated with those pucks. However, a greater or fewer number of controllers could be employed without departing from the scope of the present invention.

Each of the controllers **80** therefore controls six of the pucks **18**. The channels can conveniently be identified as channels A, B, C, D, E and F. The controller **80** obtains information identifying the position of each of the pucks **18** which it is to control. Information relating to the position of the pucks **18** is fed to the controller **80** from the encoder **68** on the pulleys **46**.

Information relating to a truss layout is fed into the PC and that information is then provided to the controller **80**. Initially the pucks **18** are moved to a zero position by the controller **80**. The controller **80** selects channel A, for example, and knowing the position of the puck associated with that channel, it will compare the required position to the actual position of the puck **18** (and of the carriage **38** carrying a puck and cylinder **56**). A command is issued from the controller **80** to the brake **66** associated with the relevant puck **18** so that the brake **66** is released. An output is supplied to solenoid **70** to ensure that the shaft **60** is moved into the position so that the spline **62** or **64** engages the appropriate pulley **46** and a voltage is supplied to the motor M to drive the shaft **60** at high speed. The shaft **60** rotates the pulley **46** to drive the appropriate belt **52** about the pulleys **46** and **48** to move the support platform **40** to the desired position to correctly position the puck **18**. When the puck **18** comes to within a specified distance from its required position (which may be indicated by a number of counts issued from encoder **68**) the motor speed is switched to low speed by the controller **80**. Typically this will occur after one or two seconds of running. Again, when the puck **18** is within the specific number of counts of the actual position required, the controller **80** issues a signal to disc brake **66** to apply the brake **66** to stop the pulley **46** so that the puck **18** comes to rest at the required position. The motor M is then switched off. The specific number of counts at which the motor is reduced to low speed and at which the brake is applied can be determined by the system response time and could be adjustable and preset in the controller **80**. The controller then selects channel B so that the next puck can be moved. The solenoid **70** is operated to disengage splines **62** of shaft **60** from the pulley **46** and to engage the other spline **64** with its pulley **46**. The same procedure as outlined above is then repeated. Similar operations occur for channels C and D and for channels E and F so that each of the pucks can be positioned in a required position.

For any truss configuration only some of the pucks which may be provided may be used. Those pucks which need not be used for a particular truss configuration can be controlled so that they are merely moved to the edge of the table so that they are completely out of the way of the truss **20** which is to be manufactured.

Thus, according to the preferred embodiment of the invention, the jig system can be automatically set up to receive components of a truss and the truss can be easily manipulated to enable connector plates to be inserted in place for formation of the truss. Thus, not only is set up of the jig quickly effected, but formation of the truss is also more easily and quickly performed.

Since modifications within the spirit and scope of the invention may readily be effected by persons or ordinary skill in the art, it is to be understood that this invention is not limited to the particular embodiment described by way of example hereinabove.

What is claimed is:

1. A jig system for use in arranging components to form an assembly such as a truss, the jig system comprising:

an upper platform;

stops mounted for translational movement generally along respective lines to desired positions for locating the components to form the assembly, at least a portion of each stop being disposed above the upper platform;

stop moving means for the stops, said stop moving means comprising a motive source, a driver acted on by the motive source for moving the driver, the driver being disposed below the upper platform, at least part of the driver being movable in a direction parallel to the line of movement of the stop, means for connecting the driver to the stop for moving the stop along its line of motion to the desired position.

2. A jig system as set forth in claim **1** wherein the driver comprises a drive wheel member, said motive source being adapted for connection to the drive wheel member for powering rotation of the drive wheel member, and wherein said connecting means comprises an endless flexible member extending in a circuit between the drive wheel member and another wheel member, the endless flexible member being driven by the drive wheel member for movement around the circuit and being coupled to the stop for movement of the stop with the flexible member.

3. A jig system as set forth in claim **2** wherein the endless flexible member comprises an endless belt, the drive wheel member and said other wheel member comprising pulleys around which the endless belt extends.

4. A jig system as set forth in claim 2 further comprising clamping means for clamping the components against the stops.

5. A jig system as set forth in claim 4 wherein said clamping means comprises clamps mounted for movement with corresponding stops, the clamps being capable of actuation from a remote location.

6. A jig system as set forth in claim 2 further comprising rails and carriages riding on the rails which are connected to corresponding endless flexible members for movement with the endless flexible members, the carriages carrying the stops and clamps.

7. A jig system as set forth in claim 2 wherein the upper platform includes a reaction surface for supporting the components as connectors are driven into the components to connect the components together, the jig system further comprising:

component supports for supporting components of the assembly, the component supports mounting the stops and being movable relative to the reaction surface to place the stops in the desired positions;

resilient members for supporting the component supports away from the reaction surface so that connectors may be positioned between the components and the reaction surface, the resilient members being resiliently yieldable under a force applied to the components to move the component supports for pressing the connectors and the components against the reaction surface to drive the connectors onto the components.

8. A jig system as set forth in claim 2 wherein the motive source comprises a plurality of motors, and wherein the jig system further comprises a drive shaft associated with each motor and means for selectively engaging the drive shaft with the drive pulleys associated with different endless flexible members for driving the flexible members independently of each other.

9. A jig system as set forth in claim 8 wherein said means for selectively engaging the drive shaft with the drive pulleys comprises a solenoid associated with each drive shaft for moving the drive shaft longitudinally, the drive shaft having two sets of splines thereon, one set of splines being engageable with one of the drive pulleys for interconnecting the motor and the one drive pulley and the other set of splines being engageable with the other of the drive pulleys for interconnecting the motor and the other drive pulley.

10. A jig system as set forth in claim 1 further comprising a control system for individually controlling the movement of the stops to place the stops in the predetermined desired positions according to the shape of the assembly to be formed.

11. A jig system for use in arranging components to form assemblies such as trusses of different configurations, the jig system comprising:

stops mounted for translational movement generally along respective lines to different desired positions for locating the components to form the assemblies having different configurations;

powered clamping means for clamping the components against the stops, said powered clamping means being mounted for translational movement to different desired positions for locating components to form the assemblies of different configurations, and being operable for powered clamping of components against the stops in different desired positions of the stops.

12. A jig system as set forth in claim 11 wherein said clamping means comprises clamps mounted for movement with corresponding stops, the clamps being capable of actuation from a remote location.

13. A jig system as set forth in claim 12 further comprising rails and carriages riding on the rails, the carriages carrying the stops and clamps.

14. A jig system as set forth in claim 11 further comprising a control system for individually controlling the movement of the stops to place the stops in the predetermined desired positions according to the shape of the assembly to be formed.

15. A jig system for use in association with reaction surface means to arrange components to form an assembly such as a truss, and to support the components as connectors are driven into the components to connect the components together, the jig system comprising:

stops for locating the components to form the assembly;

component supports for supporting components of the assembly;

resilient members for supporting the component supports away from the reaction surface means so that connectors may be positioned between the components and the reaction surface means, the resilient members being resiliently yieldable under a force applied to the components to move the component supports to press the connectors and the components against the reaction surface means to drive the connectors onto the components.

16. A jig system as set forth in claim 15 wherein the component supports mount the stops and are movable relative to the reaction surface means to place the stops in desired positions to form the assembly.

17. A jig system as set forth in claim 16 further comprising clamping means for clamping the components against the stops.

18. A jig system as set forth in claim 17 wherein said clamping means comprises clamps mounted on the component supports for movement with corresponding stops, the clamps being capable of actuation from a remote location.

19. A jig system as set forth in claim 18 further comprising rails and carriages riding on the rails, the carriages carrying component supports.

20. A jig system as set forth in claim 15 further comprising a control system for individually controlling the movement of the stops to place the stops in the predetermined desired positions according to the shape of the assembly to be formed.

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